



<http://www.epa.gov/otaq/technology>

**Clean Automotive Technology ...
... Innovation that Works**

A Path to More Sustainable Transportation

2004 DEER Conference

29 August, 2004

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Today's cars and trucks are cleaner than ever: a key element of “sustainable transportation”

A large part of “sustainability” is reducing criteria pollutants (i.e., NOx, PM, HC and CO), to necessary levels

- ◆ LD automotive manufacturers are in production and meeting the **LD Tier 2** standards
- ◆ All HD engine manufacturers have assured EPA that they on track with product that meets the **HD2007** standards
- ◆ **Non-Road Tier 4** vehicles achieving standards will round off the tools to meet the goal of cleaner air from mobile sources

Other elements of *Sustainable Solutions* for the Transportation Sector

◆ ENVIRONMENTAL SUSTAINABILITY

- Criteria Pollutants (health of the population)
- Climate Change (health of the planet)

◆ ENERGY SUSTAINABILITY

- Geopolitics of Oil reserves (Stable, National Security)
- A finite supply w/ transition concerns (Available)
- Economic dependence on Oil (Affordable)

Is the Diesel on this path?

– R&D progress to date

- ◆ In the not too distant past, the diesel questions were:
 - With EPA's stringent standards, is there a future for diesel?
 - With a "practical limit" of diesel combustion not allowing engine-out NOx below 1.5 gm/hp/hr, can any NOx aftertreatment retain 80-90% lifetime effectiveness?
 - How can we address climate change and improve fuel economy without jeopardizing health and safety?
- ◆ Today the questions are:
 - What is the lowest cost approach for a Tier 2 bin 5 diesel?
 - Will Americans overcome their historical perception of the diesel, and consider a diesel in their family sedan (or SUV)?
 - What is the most logical approach to fuel economy improvement, diesels or hybrids?

Clean Automotive Technologies Under Development at the U.S. EPA's National Vehicle & Fuel Emissions Laboratory

◆ Advanced engine concepts

- Clean Diesel Combustion
- HCCI
- Free Piston Engines
- (Alternative Fueled Engines)
- (Efficiency Improving "Bottoming Cycles")



◆ Advanced Hydraulic Hybrid Vehicles & components

- Improved Hydraulic Components
(pumps, motors, valves, accumulators, etc)
- Sport Utility Vehicle DEMO (Class 2)
- Urban Delivery Vehicle DEMO (Class 5-7)
- Heavier Utility Vehicles DEMO
(Trash Trucks, Dump Trucks, Buses)

Diesel Options to Meet HD On-Road or LD Tier 2 Emissions Levels

◆ NOx Adsorber Aftertreatment

- viable approach (primary path for compliance)

◆ SCR Aftertreatment

- infrastructure, cost, significant compliance and enforcement concerns – engine manufacturers would be fully responsible for in-use compliance

◆ HCCI Combustion

- technology approach not yet mature

◆ **Clean Diesel Combustion**

Control NOx engine-out

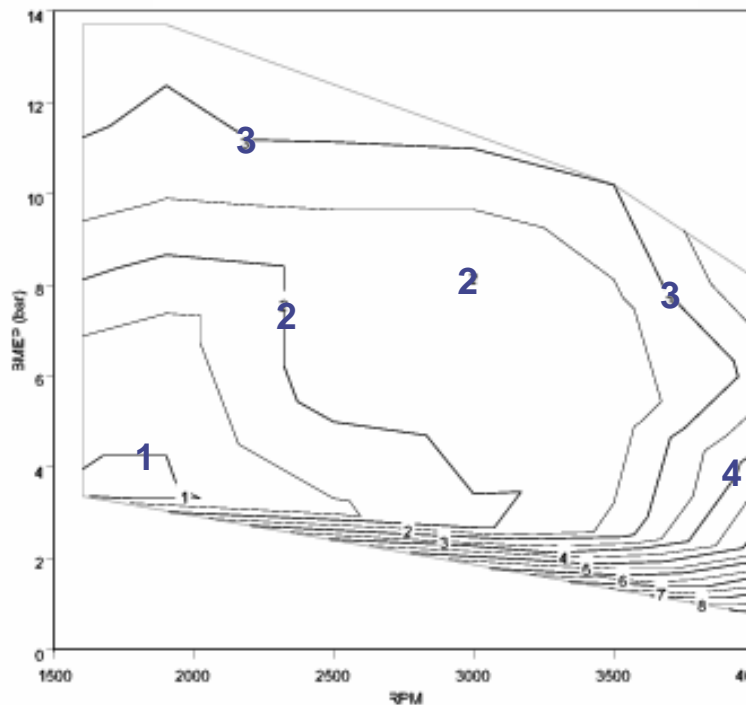
& Smoke/PM/HC with conventional aftertreatment

Comparing *Engine-Out NOx* of Conventional and EPA's CDC diesels

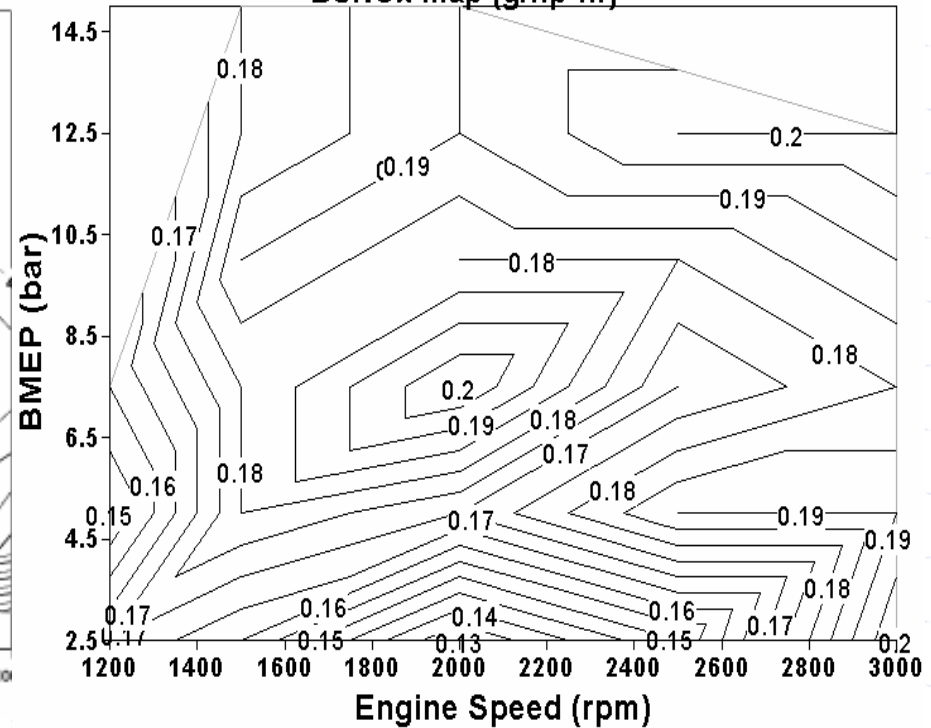
Conventional Diesel 1.9L

CDC Diesel 1.9L

NOx Engine Out (g/hp-hr)

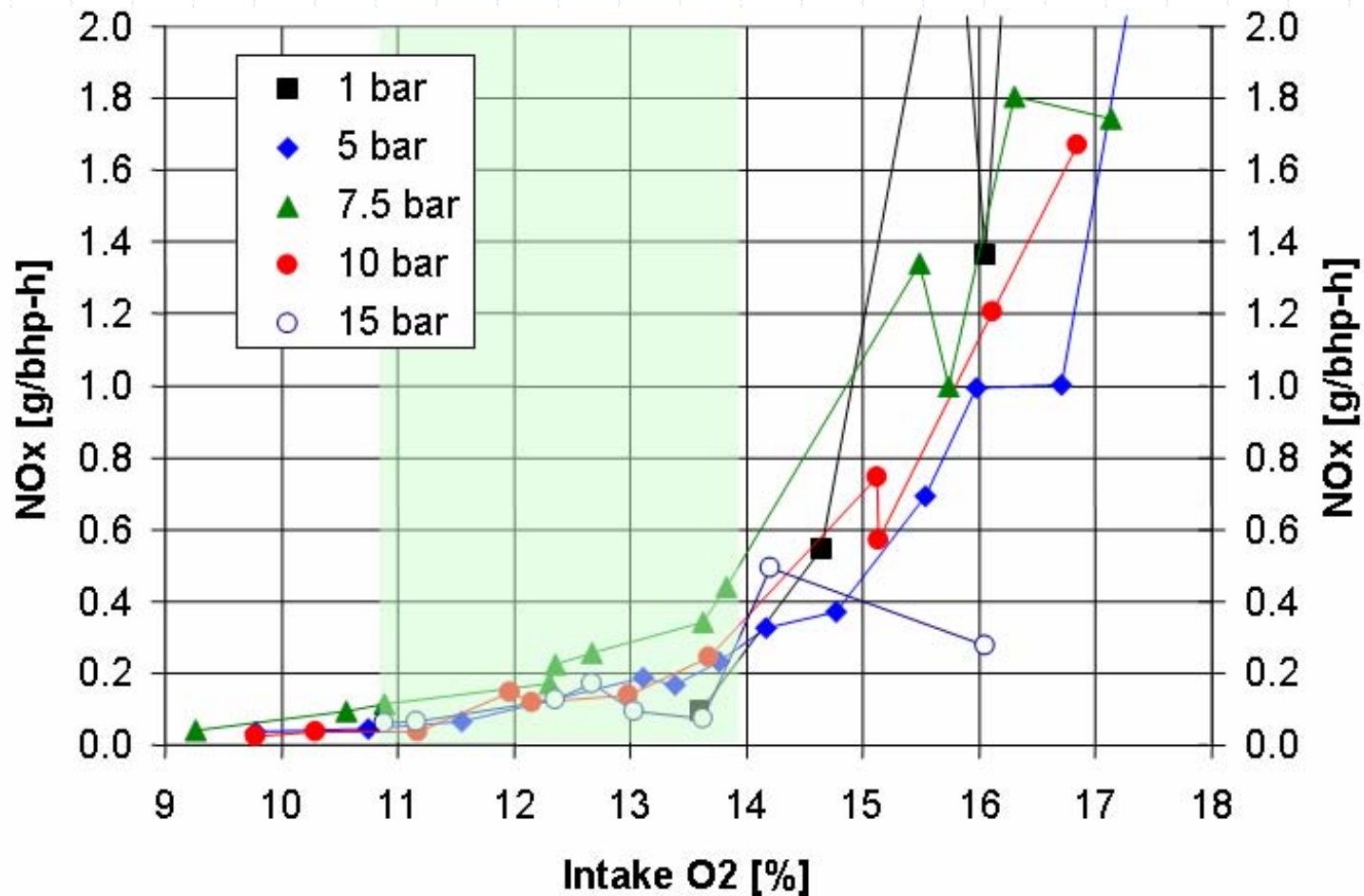


BSNOx Map (g/hp-hr)

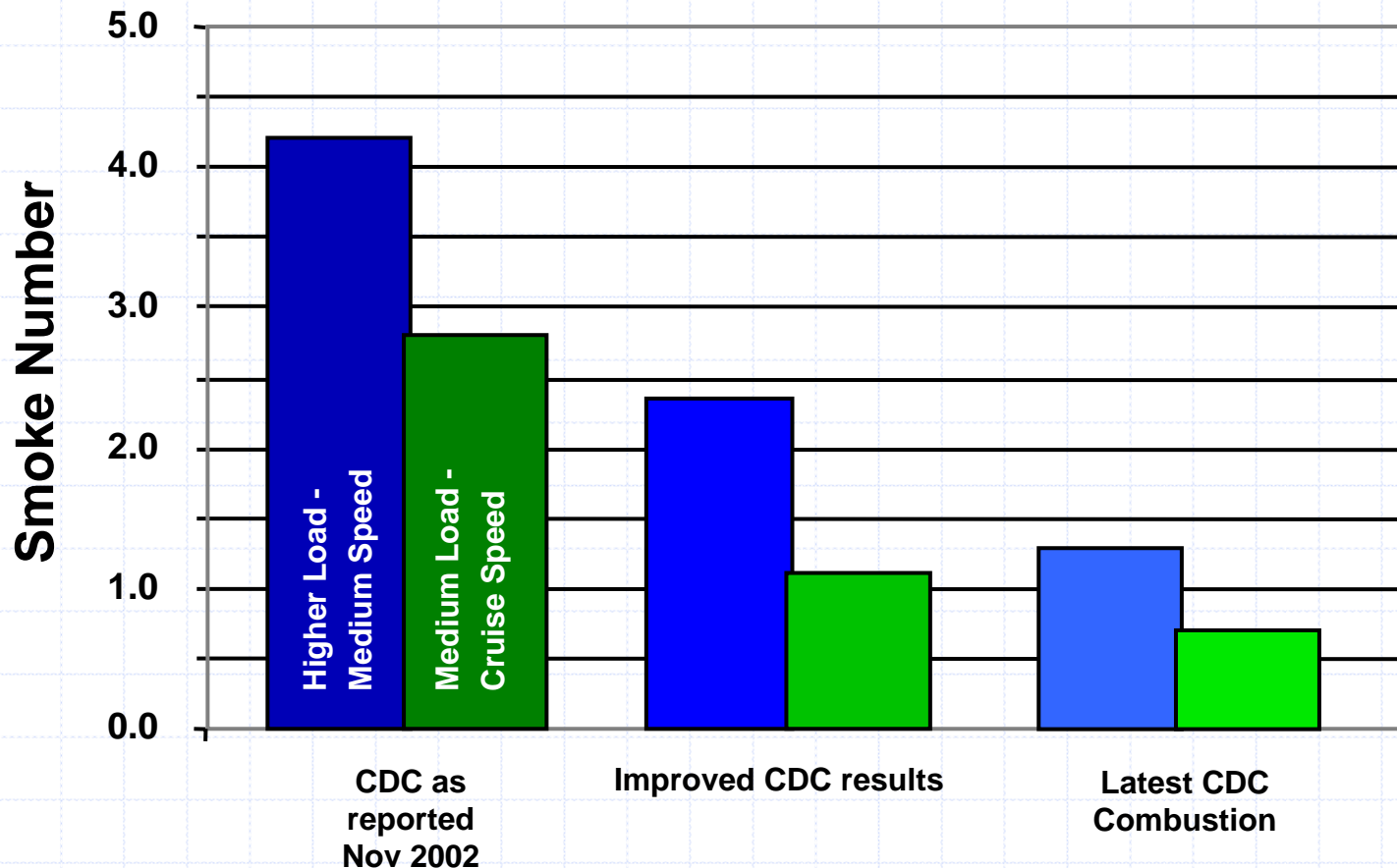


NOx below .2 everywhere

EPA's Approach to Clean Diesel Combustion NOx Control

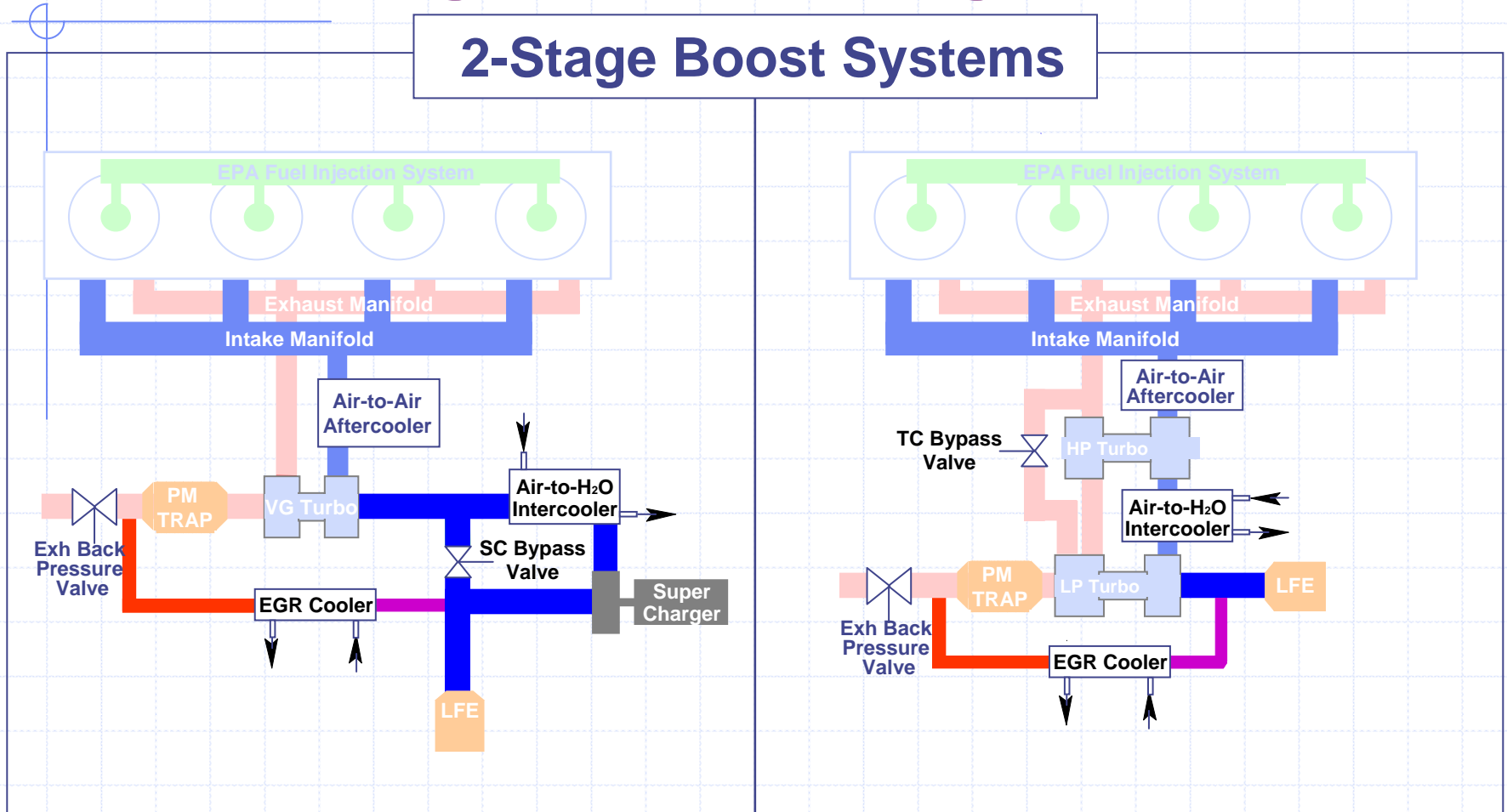


Improving the Performance and Reducing PM from Clean Diesel Combustion



EPA's Clean Diesel Combustion Air Management Configurations

2-Stage Boost Systems



Clean Diesel Combustion

Initial Vehicle Test Results

Engine	Test Fuel Economy (mpg)	HC(g/mi)	CO	NOx	PM		
Stock	FTP city	32		0.05	0.10	0.8	0.028
	FTP hwy	49		0.01	0.02	0.7	0.027
	US06	32		0.01	0.03	1.8	0.069
Tier 2	Bin 5 (120k mi)			0.018	4.20	0.07	0.010
CDC	FTP city	30		0.23	1.12	0.06	0.001
	FTP hwy	47		0.10	0.18	0.05	0.0004
	US06	26		0.20	0.07	0.14	0.008

VEHICLE: ~ 4,900 lb test weight
a larger-wagon or mini-van

EPA Clean Diesel Combustion Our Research is Continuing...

- Five CRADA/Technology Transfer partners active in developing this technology
- Continued refinement of combustion, boost, & fuel injection to better systems and approaches
- Transient calibration has not been as challenging as expected, but diesel NVH & drivability need more work
- Improving aftertreatment for PM, HC & CO reduction
- Continuing vehicle demonstrations beyond FTP & US-06 capability

For More Information



Information on the Regs – www.epa.gov/cleandiesel

Information on Technologies – www.epa.gov/otaq/technology

- ◆ Fact Sheet - *Clean Diesel Combustion: Clean, Efficient, and Cost Effective*
- ◆ Fact Sheet - *Hydraulic Hybrid Technology: A Proven Approach*
- ◆ Technical Information - *An HCCI Engine Power Plant for a Hybrid Vehicle*
- ◆ Interim Technical Report - *Progress Report on Clean and Efficient Automotive Technologies Under Development at EPA - January 2004*